Listing of Claims

1. (Currently amended) A method for producing a lithographically printed image having a reduced critical dimension, the method comprising:

providing a semiconductor substrate;

providing an underlayer on said substrate wherein said underlayer is ~~a tuned~~ an optically-optimized polymer substantially free of any element that forms a non-volatile oxide;

providing a photoresist layer on said underlayer, wherein said photoresist comprises a material capable of forming a non-volatile, etch-resistant oxide;

imagewise exposing said photoresist layer to radiation forming an image in said photoresist;

transferring said image into said underlayer; and

performing a controlled overetch of said underlayer.

etching said underlayer with a plasma; and

performing a controlled lateral thinning of said underlayer.

2. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said underlayer comprises less than 9% silicon.

3. (Currently amended) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said ~~underlayer comprises a tuned~~ optically-optimized polymer comprises a polymer having, at an imaging wavelength, a refractive index of from about 1.7 to about 1.9 and an extinction coefficient of from about 0.20 to about 0.22.

4. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said underlayer is substantially free of any element that forms a non-volatile oxide wherein said element is

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selected from the group consisting of silicon, boron, phosphorous, germanium, and aluminum.

5. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said photoresist comprises an element capable of forming a non-volatile, etch-resistant oxide selected from the group consisting of silicon, boron, phosphorous, germanium, and.

6. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein the reactive species of said plasma comprises neutrals and ions selected from the group consisting of oxygen, hydrogen, fluorine, and chlorine.

7. (Currently amended) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said underlayer comprises ~~a tuned~~ <u>an optically-optimized</u> polymer comprising carbon, hydrogen, and oxygen.

8. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said underlayer comprises an antireflective coating.

9. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said photoresist comprises a radiation-sensitive acid generator.

10. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said photoresist comprises a polymer having acid-cleavable moieties bound thereto.

11. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said photoresist comprises

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a polymer formed by polymerizing one or more monomers selected from the group consisting of acrylate, methacrylate, hydroxystyrene optionally substituted with C_{1-6}-alkyl, C_{5-20} cyclic olefin monomers, and combinations thereof, the polymer having acid-cleavable moieties bound thereto, wherein all such moieties are silylethoxy groups optionally substituted on the ethoxy portion thereof with C_{1-6}-alkyl, phenyl, or benzyl.

12. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said radiation is selected from the group consisting of electromagnetic radiation, 157-365 nm ultraviolet radiation, euv, electron beam radiation, and hard and soft x-ray radiation.

13. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said radiation comprises ultraviolet radiation or extreme ultraviolet radiation.

14. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 12, wherein said ultraviolet radiation comprises substantially monochromatic radiation having a wavelength of from about 157 nm to about 365 nm.

15. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 12, wherein said ultraviolet radiation comprises substantially monochromatic radiation having a wavelength selected from the group consisting of 157, 193, 248, 254, and 365 nm.

16. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said radiation comprises x-ray radiation.

17. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said photoresist comprises

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a stable, etch-resistant, non-volatile oxide-forming material selected from the group consisting of silicon, phosphorous, germanium, aluminum, and boron.

18. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said plasma comprises a reactive species selected from the group consisting of oxygen, hydrogen, fluorine, and chlorine.

19. (Currently amended) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein said ~~tuned~~ optically-optimized polymer comprises an organic polymer selected from the group consisting of phenolic polymers, novolacs, epoxies, and diamond-like carbon.

20. (Previously presented) The method for producing a lithographically printed image having a reduced critical dimension, according to claim 1, wherein transferring said image comprises plasma reactive-ion etching.

21. (Previously presented) The method for producing a lithographically printed image having a reduced critical dimension, according to claim 18, wherein said reactive species comprise neutrals and ions.

22. (Previously presented) The method for producing a lithographically printed image having a reduced critical dimension, according to claim 1, wherein performing controlled overetch comprises controlling the etch rate.

23. (Previously presented) The method for producing a lithographically printed image having a reduced critical dimension, according to claim 22, wherein controlling said etch rate comprises adding a non-reactive diluent gas to said plasma.

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24. (Previously presented) The method for producing a lithographically printed image having a reduced critical dimension, according to claim 23, wherein said non-reactive diluent gas comprises nitrogen and noble gasses.

25. (Previously presented) The method for producing a lithographically printed image having a reduced critical dimension, according to claim 22, wherein controlling said etch rate comprises regulating process parameters.

26. (Previously presented) The method for producing a lithographically printed image having a reduced critical dimension, according to claim 25, wherein said process parameters consist of variables selected from the group consisting of the duration of etch, the rf power, operating pressure, gas flowrates, backside He pressure, electrode temperature, and wall temperature.

27. (Previously presented) The reduced critical dimension bilayer resist image comprising:

a semiconductor substrate;

an organic layer provided on said substrate; and a photoresist layer provided on said organic layer, wherein said photoresist layer has a first image developed therein, and wherein said organic layer has a second image, of reduced critical dimension and congruent with said first image, developed therein.

28. (Previously presented) A method of using a reduced critical dimension bilayer resist image comprising:

providing a substrate;

forming a reduced critical dimension bilayer resist image on said substrate;

transferring said image into said substrate forming a circuit image; and

forming circuit element materials in said circuit image.

29. (Previously presented) The method of using the reduced critical dimension bilayer resist image, according to claim 25 wherein said circuit element materials comprise

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materials selected from the group consisting of dielectric, conductor, semiconductor, and doped semiconductor materials.

30. (Previously presented) A semiconductor device fabricated using a reduced critical dimension bilayer resist image.

31. (Previously presented) The method for reducing the critical dimension of a lithographically printed feature, according to claim 1, wherein

said substrate has a hardmask defined thereon, and

said underlayer is provided on said hardmask.

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